Palaeontological Study of Nukumaruan and Waitotaran Rocks near Wanganui.

By C. R. Laws, D.Sc., Auckland.

[*Read before the Auckland Institute, August 18, 1939; received by the Editor, October 5, 1939; issued separately, June, 1940.*]

Introduction.

Several years ago the writer closely studied the fossils occurring at Kaawa Creek, South of Waikato Heads, in beds that on palaeontological grounds have been assigned to the Waitotaran Stage of the Wanganui System. These beds were found to be rich in small molluscs, in addition to the larger forms that had already been recorded by Bartrum and Powell (*Trans. N.Z. Inst.*, vol. 59, pp. 139-162, 1929). In one of his papers relating to the Kaawa faunule (*Trans. Roy. Soc. N.Z.*, vol. 66, pt. 1, pp. 38-59, 1936) the writer pointed out that exact correlation was a matter of some difficulty, and made the following statement (*loc. cit.*, p. 40) :—" The high percentage of species that are peculiar to the beds, together with the small number found in Pliocene rocks elsewhere in New Zealand, shows that the faunule is definitely an isolated one, ——. When the faunule is compared with that at Hawera the difficulty of correlation becomes further apparent, for the Kaawa and Hawera beds belong to different facies, and on the whole the assemblage of species differs at each locality, there being only 19 species that are common to both. A striking feature of the faunule at Kaawa is the entire absence of such typical Waitotaran fossils as the large pelecypods *Chlamys triphooki, Sectipecten crawfordi, Ostrea ingens**, *Cardium spatiosum.* ——. The revised faunal list for Hawera given by Powell (*Rec. Auck. Inst. Mus.*, vol. 1, no. 2, p. 87, 1931) shows a total absence of minutae, and as these are well represented in the faunule at Kaawa, correlation is made still more difficult. Not until a facies of the Taranaki Waitotaran is found in which minutae are represented can precise comparisons be made."

An attempt to obtain minutae from several localities along the section between, and including, Nukumaru Beach and Waihi Beach, Hawera, was recently made with moderate success. Shortage of time made it necessary to limit collecting to a very brief interval (two to three hours) at each locality, and to devote most of this time to searching for matrix that appeared likely to yield small shells, little attention being given to collecting the larger species. Collections of matrix were thus made at Nukumaru Beach, Wilkie's Bluff (Waitotara), Mangapani (12 miles by road upstream from Waitotara Township), and Waihi Beach, Hawera.

* *O. ingens*, however, has since been collected at Kaawa Creek.

The present paper includes description of new species and furnishes new records; in addition to these, an attempt is made to define more precisely than has been possible in the past the limit that should be drawn between the Nukumaruan and Waitotaran Stages of the Wanganui System.

Park (*Repts. Geol. Explor.* during 1886-87, no. 18, p. 57, 1887) placed the *Rotella* beds at Nukumaru in the Newer Pliocene, the Nukumaru Limestone in Older Pliocene, and the Coralline Series at Waitotara in the Upper Miocene. The palaeontological observations made in this paper go to show that actually these three horizons are not so widely separable as Park thought, but are sufficiently close in faunal characteristics to be grouped together.

Although based originally on Park's Waitotara Coralline Series as developed at Wilkie's Bluff, Waitotara (Park, *loc. cit.*, pp. 55 and 64), as conceived at present the Waitotaran includes the succession of beds from Waitotara to beyond Hawera; it is here shown, however, to contain two distinct faunal communities. Certain upper members of the sequence must be withdrawn from the Waitotaran Stage; but they need not be recognised as an additional stage for they contain a faunule that is essentially Nukumaruan.

FAUNAL LISTS.

The lists given below, with the exception of that for Waihi Beach, Hawera, do not represent the full muster of species at the various localities, those for Wilkie's Bluff and Mangapani including only those species obtained during the visits recently made by the writer. Though not comprehensive, these lists supply strong evidence regarding the correlation of certain beds along part of the Nukumaru-Hawera coastal section, and, as will be shown, assist in indicating more accurately than has hitherto been possible the sectional division between the Nukumaruan and Waitotaran Stages.

	Nukumaru Beach.	Wilkie's Bluff.	Mangapani.	Waipipi.	Waihi Beach, Hawera.
PELECYPODA.					
Nucula nitidula A. Ad.	—	—	—		—
N. (Linucula) wanganuica n.sp.	—	—			—
N. (Linucula) aptera n.sp.				—	—
Nuculana (Saccella) waihiana Pow.				—	—
Neilo annectens Powell.	—	—	—		—
Anomia undata Hutton.					—
Glycymeris manaiaensis Marw.				—	
Glycymeris waipipiensis Marw.				—	—
Glycymeris laticostata (Q. and G.)		—	—		
Glycymeris modesta (Angas).					

	Nukumaru Beach.	Wilkie's Bluff.	Mangapani.	Waipipi.	Waihi Beach, Hawera.
Hochstetteria waitotara n.sp.		—			
Cosa trigonopsis (Hutton).	—	—			
Mytilus canaliculus (Mart).					
Isognomon zelandicum (Sut.)	—			—	—
Chlamys radiatus (Hutton).		—		—	—
Phialopecten triphooki (Zitt.)			—	—	—
Sectipecten crawfordi (Hutt.)				—	—
Pallium waikohuensis Marw.					—
Lima waipipiensis M. and M.				—	—
Limatula maoria Finlay.		—			
Mantellum marwicki Powell.				—	—
Crassostrea ingens (Zitt.)	*				
Ostrea charlottae Finlay.	—	—		—	—
Eucrassatella marshalli Powell.		—		—	—
Talabrica senecta Powell.		—			
Cuna morator n.sp.					
Cuna laqueus Finlay.					—
Cuna nukumaruensis n.sp.	—	—			
Pleuromeris marshalli Marwick.		—			
Pleuromeris finlayi Powell.	—	—			
Condylocardia dupliora Laws.	—		—		
Pteromyrtea dispar (Hutton).	—			—	—
Divaricella cumingi (Ad. and Ang.)				—	—
Miltha neozelanica M. and M.				—	
Zemysia ampla (Hutton).					—
Notolepton antipodum (Fil.)	—	—			
Pachykellya concentrica Powell.	—	—	—		
Pachykellya rotunda Powell.	—	—	—		
Puyseguria wanganuica Powell.	—	—	—		
Arthritica dispar Laws.	—	—	—		
Arthritica bifurca (Webster).	—	—			—
Melliterya parva (Desh.)	—				—
Myllitella finlayi Marwick.		—			
Virmysella n.sp.	—		—		
Virmysella cf. *tellinula* (Odhner.)	—	—			—
Tellinella ferrari Marwick.					—
Tellinella cf. *eugonia* (Suter).				—	—
Eurytellina solitaria Powell.					—
Paphies australis (Gmel.)					
Scalpomactra scalpellum (Rve.)			—		
Spisula aequilateralis (Desh.)			—		—
Zenatia acinaces (Q. and G.)			—		
Lutraria solida Hutton.	—	—			—
Dosinia lambata (Gould).				—	
Dosinia (Kereia) greyi Zitt.					—
Dosinia (Raina) nukumaruensis Marw.	—			—	—
Dosinia (Raina) waipipiensis Marw.					—
Notocallista (Striacallista) multistriata (Sow.)				—	
Marama murdochi Marwick.				—	—
Dosinula zelandica (Gray).				—	—

* Recorded by Marshall and Murdoch (*Trans. N.Z. Inst.*, vol. 52, p. 123, 1920).

	Nukumaru Beach.	Wilkie's Bluff.	Mangapani.	Waipipi.	Waihi Beach, Hawera.
Tawera errans Marwick.				—	—
Tawera subsulcata (Suter).	—		—	—	—
Bassina yatei (Gray).	—				
Chione (Austrovenus) crassitesta Fin.			—		
Eumarcia plana Marwick.	—		—	—	
Eumarcia (Atamarcia) benhami Marw.			—	—	
Cardium spatiosum Hutton.		—		—	—
Nemocardium pulchellum (Gray).				—	—
Gari lineolata (Gray).				—	—
Gari stangeri (Gray).			—		
Anisocorbula zelandica (Q. and G.).		—		—	
Hiatella australis (Lam.).			—		
Panope zelandica (Q. and G.).	—			—	—
Offadesma angasi (Crosse and Fischer).					—
Pholadomya waitotarana Powell.				—	
Myadora waitotarana Powell.					—
Myadora subrostrata Smith.	—		—		
GASTEROPODA.					
Scissurona fossilis n.sp.	—	—			
Schismope sp.		—			
Emarginula striatula Q. and G.		—			
Emarginula haweraensis Powell.					—
Trochus (Coelotrochus) tiaratus Q. and G.		—	—		
Microlenchus sanguineus (Gray).	—	—	—		
Maurea hawera (Oliver).				—	—
Maurea hodgei (Hutton).	—	—	—		
Maurea n.sp.					—
Maurea (Mucrinops) granti Powell.					—
Antisolarium conominolium Laws.					—
Zethalia zelandica (A. Ad.).	—	—	—		
Elachorbis cingulata (Bartrum).					—
Elachorbis hawera n.sp.					—
Elachorbis unicarina n.sp.		—	—		
Liotella cf. *rotula* (Suter).		—			
Brookula (Aequispirella) corulum (Hutton).	—	—			
Brookula (Aequispirella) cf. *finlayi* Pow.		—			
Dolicrossea vesca Finlay.		—			
Crosseola waitotara n.sp.		—			
Argalista fluctuata (Hutton).	—	—			
Estea impressa (Hutton).	—	—			
Estea semisulcata (Hutton).	—	—	—		
Estea rugosa (Hutton).	—	—			
Estea rekominor n.sp.	—	—			
Estea jocosa n.sp.		—			
Estea missile n.sp.	—		—		
Nobolira charassa (Finlay).	—	—			
Scrobs kaawaensis Laws.	—		—		
Manawatawhia aedicula n.sp.		—			
Dardanula cf. *olivacea* (Hutton).	—	—			
Nozeba emarginata (Hutton).		—			
Zeacumantus lutulentus (Kiener).	—		—		
Specula cf. *retifera* (Suter).	—		—		

	Nukumaru Beach.	Wilkie's Bluff.	Mangapani.	Waipipi.	Waihi Beach, Hawera.
Lyroscila chathamensis (Suter).	—	—	—		—
Ataxocerithium simplex Marwick.					—
Notosinister (Cautotriphora) simulans n.sp.	—	—			
Caecum digitulum Hedley.	—	—			
Maoricolpus aff. *roseus* (Q. and G.).	—	—	—		
Maoricolpus cf. *roseus* (Q. and G.).				—	—
Zeacolpus vittatus (Hutton).	—				—
Zeacolpus propagodus n.sp.		—			
Stiracolpus waikopiroensis (Suter).		—			
Stiracolpus haweraensis Powell.		—	—	—	—
Struthiolaria papulosa (Martyn).					—
Pelicaria incrassata Powell.					—
Pelicaria zelandiae (M. and M.).				—	—
Maoricrypta wilckensi (Finlay).				—	—
Maoricrypta sp.	—	—	—		
Sigapatella novaezelandiae Lesson.	—	—	—		
Zegalerus crater Finlay.	—				—
Zegalerus tenuis (Gray).	—		—		—
Taniella planisuturalis (Marwick).		—	—	—	—
Tanea socia (Finlay).					—
Polinices ovuloides (Marwick).				—	—
Polinices waipipiensis (Marwick).			—	—	—
Polinices pateaensis (Marwick).			—		
Friginatica marshalli Marwick.				—	—
Sinum cf. *marwicki* Laws.					—
Globisinum flemingi Powell.				—	
Cerithioderma cavatocarinata n.sp.	—		—		
Cerithioderma (Miplioderma) mangawera n.sp.			—		—
Xenophalium fibratum (M. and M.).				—	—
Heligmope postulatus Bartrum).					—
Cirsotrema zelebori (Dunker).	—	—			
Funiscala nympha (Hutton).			—		
? Acirsa n.sp.					—
Turbonilla cf. *stoneleighana* Laws.		—			
Chemnitzia kingi Laws.	—	—			
Chemnitzia petaneana Laws.	—		—		
Chemnitzia ngatutura Laws.					—
Eulimella levilirata (Suter).	—		—		
Eulimella deplexa Hutton.	—	—	—		
Eulimella sp.			—		
Odostomia zecorpulenta Laws.	—	—	—		
Odostomia castlecliffensis Laws.		—			
Odostomia bartrumi Laws.					—
Odostomia cf. *turneri* Laws.					—
Odostomia n.sp.					—
Odostomia sp.	—	—	—		
Gumina minor n.sp.			—		
Evalea liricincta Suter.	—		—		
Evalea n.sp.					—
Waikura n.sp.					—
Pyrgulina rugata Hutton.	—		—		
Pyrgulina rugata n.subsp.					—

	Nukumaru Beach.	Wilkie's Bluff.	Mangapani.	Waipipi.	Waihi Beach, Hawera.
Balcis christyi (Marwick).	—	—			
Verconella haweraensis Powell.					—
Verconella aff. *dilatata* (Q. and G.).				—	—
Aeneator contractus n.sp.					—
Austrofusus pagoda Finlay.				—	—
Zelandiella pliocenica Powell.			—	—	—
Coluzea spectabilis Powell.					—
Poirieria zelandica (Q. and G.).					—
Zeatrophon ambiguus (Phil).		—	—		
Zeatrophon bonnetti (Cossm).	—				—
Xymenella gouldi (Cossm).	—	—	—		
Xymenella pusilla (Suter).					—
Paratrophon cheesemani (Hutton).			—		
Neothais cf. *scalaris* (Menke).			—		
Inglisella hirta Laws.					—
Merica haweraensis n.sp.					—
Zemitrella sp.	—	—			
Zemitrella cf. *websteri* (Suter).		—			
Zafra impedita n.sp.		—	—		—
Alcithoe gatesi Marwick.				—	—
Alcithoe whakinoensis Marwick.			—	—	—
Alcithoe haweraensis Marwick.					—
Alcithoe larochei Marwick.					—
Olivella neozelanica (Hutton).				—	—
Baryspira australis (Sow.).	—		—		
Baryspira mucronata (Sow.).		—		—	—
Alocospira subhebera (Marwick).					—
Austrotoma prolixa n.sp.					—
Austrodrillia koruahinensis Bartrum and Powell.					—
Bathytoma hawera n.sp.					—
Comitas declivis Powell.					—
Neoguraleus sinclairi (Smith).	—	—	—		
Guraleus n.sp.			—		
Liracraea sata Laws.					—
Liracraea cf. *sata* Laws.					—
Marshallena austrotomoides Powell.					—
Phenatoma decessor Marwick.					—
Phenatoma rosea (Q. and G.).		—	—		
Zeacuminia murdochi Powell.				—	—
Zeacuminia planitas n.sp.					—
Pervicacia tristis (Desh.).	—	—	—		
Perirhoe bicorona (Hutton).					—
Rhizorus marwicki Bartrum and Powell.					—
Cylichnania cf. *bartrumi* Marwick.					—
Kaitoa cf. *recta* Marwick.					—
Dentalium pareorense Pils. and Sharpe.					—
Dentalium solidum Hutton.					—
Cadulus cf. *teliger* Finlay.					—

WILKIE'S BLUFF, WAITOTARA.

The beds at this outcrop constitute part of the Waitotara Coralline Series of Park, who collected from them as early as 1886, and listed the fossils in his subsequent report (*Repts. Geol. Explor.* during 1886–87, no. 18, pp. 55 and 64, 1887). Of the 77 molluscan species collected by the present writer at Wilkie's Bluff there are 55 (71·4 per cent.) that occur Recent or in younger Wanganuian beds, and that are not found at Waipipi or Hawera; and five species (6·6 per cent.) present at Wilkie's Bluff are found also at Waipipi or Hawera, but not Recent or at Wanganuian horizons higher than that at Wilkie's Bluff. Of the species not entering into these percentages five are confined to Nukumaruan beds elsewhere, six are peculiar to the beds at Wilkie's Bluff, and nine cannot be used to show affinity of the beds with either the Nukumaruan or Waitotaran since they range from Upper or mid-Pliocene into the Lower Pliocene. Perusal of the lists and consideration of the percentages and other data noted show that these beds have a fauna that is very definitely nearer to the faunule at Nukumaru than it is to that at Waipipi or at Hawera. Marshall and Murdoch (*Trans. N.Z. Inst.*, vol. 52, p. 126, 1920), in noting the occurrence of certain fossils at Wilkie's Bluff, have stated that palaeontologically the Bluff forms a connecting link between Waipipi and Nukumaru. It would now seem more exact to say that in the palaeontological chain connecting the horizons at these two places the Bluff forms a link that is located a good deal nearer the Nukumaru extremity than formerly estimated; so near, in fact, that it becomes necessary to include it with the Nukumaruan.

The presence at Wilkie's Bluff of *Zethalia zelandica,* which is so characteristic of the beds at Nukumaru Beach, and is not known fossil anywhere in beds older than Nukumaruan, is noteworthy; as also is that of *Pachykellya concentrica, Pachykellya rotunda* and *Puyseguria wanganuica,* which are found commonly in Nukumaru matrix and have Upper Pliocene rather than Lower Pliocene affinities. Other fossils in the list for Wilkie's Bluff (e.g., *Cosa trigonopsis, Talabrica senecta, Pleuromeris finlayi, Myllitella finlayi, Estea rugosa, Eulimella deplexa, Odostomia zecorpulenta, Balcis christyi, Xymene drewi*) support the conclusion that a Nukumaruan age ought to be assigned to the beds discussed. The Pyramidellid fauna, though small, is definitely Nukumaruan, and shows little resemblance to that of the Waitotaran at Hawera and at Kaawa Creek.

The presence of Nukumaruan faunas in Hawke's Bay as well as in Taranaki demonstrates that a continuous sea-way united these areas in Nukumaruan times. This has already been shown by Ongley's (*N.Z. Jour. Sc. Tech.*, vol. 16, no. 5, p. 260, 1935) recent demonstration that near Manawatu Gorge Nukumaruan sediments once formed a continuous sheet across the mountain axis of Mesozoic rocks which is shown on current geological maps of New Zealand as intervening between extensive areas of Pliocene strata on either side of this axis. It is not unreasonable to suppose that the sea

connection existed in the form of a great strait, for, as Mr. Powell has remarked to the writer, the conditions under which the oyster beds of the Coralline Series accumulated probably were analogous to those obtaining in Foveaux Strait at the present day; such supposition is not opposed to a Nukumaruan age for the beds at Waitotara.

BEDS AT MANGAPANI, WAITOTARA VALLEY.

The outcrop collected from at Mangapani extends for a chain or two along the left wall of Mangapani Valley, which enters the valley of the Waitotara River approximately from the west at a point about 12 miles by road upstream from Waitotara Township. The fossils were obtained from loose, brown, micaceous quartz-sands of shallow water character, underlying six or eight feet of a flaggy limestone (upper limit not seen) which contains large pectens here and there near its base.

Of the 64 species collected at Mangapani, 43 (67·1 per cent.) are found at Nukumaru or higher Wanganuian horizons, or are Recent, and do not occur at Waipipi or Hawera; the following eight species (12·5 per cent.) occurring at Mangapani are found also at Waipipi or Hawera, and not at Nukumaru or higher Wanganuian horizons:—*Chlamys (Phialopecten) triphooki, Eumarcia (Atamarcia) benhami, Polinices waipipiensis, Polinices pateaensis, Cerithioderma mangawera* n.sp., *Zelandiella pliocenica, Alcithoe whakinoensis, Stiracolpus haweraensis, Taniella planisuturalis.* Of the species not entering into these percentages seven range from Recent or from Upper or mid-Pliocene into the Lower Pliocene, and therefore cannot be used to show the affinity of these beds with either the Nukumaruan or Waitotaran. There are no species that are peculiar to the Mangapani faunule.

Consideration of the lists shows that the fauna of these beds is much nearer to that at Nukumaru and Wilkie's Bluff than to that at Waipipi and Hawera. *Zethalia zelandica* is not uncommon, and *Pachykellya concentrica, Pachykellya rotunda, Puyseguria wanganuica* (all present also at Wilkie's Bluff) have been collected at Mangapani. Other significant fossils that indicate alliance with the beds at Nukumaru are *Paphies australis, Tawera subsulcata, Chione crassitesta*, Myadora subrostrata, Micrelenchus sanguineus, Maurea hodgei, Elachorbis unicarinata* n.sp. (also at Wilkie's Bluff and in the Nukumaruan of Hawke's Bay), *Estea semisulcata* (very abundant), *Estea missile* n.sp., *Lyroseila chathamensis, Cerithioderma cavatocarinata* n.sp., *Funiscala nympha* (Hutton), *Chemnitzia petaneana* (also at Nukumaru and Petane), *Eulimella levilirata, Eulimella deplexa, Odostomia zecorpulenta* (also at Nukumaru, Wilkie's Bluff, Hawke's Bay), *Odostomia* sp. (of list), *Evalea liricincta, Xymenella gouldi, Xymene drewi.* The Pyramidellid faunas

* Marwick (*Trans. N.Z. Inst.*, vol. 57, p. 621, 1927) states that *C. crassitesta* is a species important to the stratigrapher as it seems to be characteristic of the Nukumaruan.

at Nukumaru, Wilkie's Bluff, Mangapani, and in Nukumaruan beds in Hawke's Bay are essentially alike, yet distinct from that at Hawera (which shows affinity with that at Kaawa Creek). At least 56·5 per cent. of the species of Mollusca found at Wilkie's Bluff, and at least 53·1 per cent. of those at Mangapani, occur also at Nukumaru.

In view of all these facts there seems little reason for hesitation in assigning the Mangapani beds to the Nukumaruan Stage.

RELATIONSHIP OF WILKIE'S BLUFF BEDS TO THOSE OF MANGAPANI.

As has been stated, the loose micaceous sands affording the fossils at Mangapani underlie a bed of limestone; and a similar lithological succession obtains near Waitotara (Park, *Repts. Geol. Explor.* during 1886-87, p. 64, 1887), where the Nukumaru limestone also rests upon micaceous sands. One is consequently called upon to consider whether the loose micaceous sands at Mangapani constitute the same horizon as that of those underlying the limestone near Waitotara. The evidence as it stands at present does not support this view, however, for, though the sections given by Park (*loc. cit.*, pp. 52-55) show the Nukumaru limestone underlain by yellowish-brown micaceous sandstones, yet the coralline beds (*Ostrea ingens* shell-bed, passing below into brown calcareous sands), which underlie the micaceous sands in the coastal section, seem at Mangapani not to be developed; and since those at Waitotara stand out in bold cliffs not only where cut by the river, but also for some distance back from the stream, it is to be expected that if present in the steep-walled Mangapani Valley such coralline beds would be in evidence in the form of more or less prominent outcrops.

The downward sequence between Nukumaru and Waitotara (Park, *loc. cit.*, p. 64) is:—

1. Nukumaru limestone.
2. Soft brown micaceous sandstones (Park makes no reference to these being fossiliferous).
3. Coralline beds (fossiliferous).
4. Yellowish-blue sandy clays.

At Mangapani the sequence exposed is:—

1. Limestone.
2. Loose brown micaceous sands with shell-bed.
3. ??? (no exposure, but if coralline beds are present one would expect them to outcrop).

Direct stratigraphical evidence on the correlation of the beds of the two areas is not at present available, though this may yet be obtained by search inland from Waitotara. Park (*loc. cit.*, p. 67) has noted the similarity in succession of the strata in the sections at Scinde Island and Pohui, Hawke's Bay, to that at Waitotara; in each case there is an upper and a lower limestone separated by about 150 feet of soft brown sandstone, the lower limestone

at Waitotara being a shell limestone passing down into brown calcareous sands (i.e., the upper part of Park's Coralline Series). May it not be that the limestone at Mangapani is equivalent to the lower calcareous beds at Waitotara? If so, the fossiliferous sands at the former locality must be lower in the sequence than the coralline beds at Wilkie's Bluff; and this is in accord with the palaeontological evidence discussed below.

The following percentages are instructive:—

	Wilkie's	Mangapani
A. Percentage of species found also at Nukumaru	56.5	53.1
B. Percentage of species found in Nukumaru and younger Wanganuian beds, or Recent, but not on Waipipi–Hawera section.	71.4	67.1
C. Percentage of species otherwise confined to Waipipi–Hawera section.	6.6	12.5

Two facts emerge from study of these percentages:—

(1) Both sets of beds are more nearly related faunally to mid- and Upper Wanganuian than to the Waipipi-Hawera beds, so nearly in fact that one is justified in assigning them to the Nukumaruan.

(2) The beds at Mangapani are slightly older than those of the Coralline Series at Waitotara.

The percentages given for A and B are respectively so close for the localities compared as to suggest that the deposits represent very nearly, if not the same, Nukumaruan horizon. There is, however, at Mangapani a greater percentage of species that are found in the Waipipi-Hawera beds (and not higher) than there is at Wilkie's Bluff (C). The large *Polinices,* which are highly characteristic of the beds at Waipipi and Hawera, and *Zelandiella pliocenica,* which also is definitely a Lower Pliocene species, are not uncommon at Mangapani, but have not been found at Wilkie's Bluff. Thus, although in both sets of beds a few survivors from the Lower Pliocene are present in a faunule that has acquired mid-Pliocene characteristics, it appears that the strata at Mangapani slightly antedate those of the coralline beds at Waitotara.

Should, however, the limestone at Mangapani prove to be the same bed as that at Nukumaru, then the fossiliferous brown sands at Mangapani must overlie the corraline beds, and it becomes necessary to explain why the palaeontological evidence supplied by the percentages for C conflicts with that of stratigraphy. It may be that further collecting at Wilkie's Bluff will bring to light additional species that are typical of the Waipipi-Hawera rocks. It is, however, not impossible to explain the apparent contradiction of palaeontological and stratigraphical evidence of age if one takes into account the possibility that some of the fossils have been derived from older beds being slowly uplifted and subjected first to wave and current erosion and later to subaerial. At first the fossil species removed and entombed in the younger series would be few in number, but this number would increase as the extent

of the older series exposed to erosion increased as uplift continued. This would account for the greater number of derived forms in later rather than in the earlier beds of the younger sequence. Another possibility is that the upper beds of the strata uplifted might be sparsely fossiliferous, and those exposed later to erosion rich in fossil species; in which case any fossils derived from the older rocks would be more commonly found in later rather than in earlier members of the younger sequence. So far as is known, however, there is no evidence of unconformable relations or of notable disconformity at the requisite horizon along the Wanganui section, but there is no stratigraphic evidence that such do not exist in the obscured portion of the coastal section between Waitotara Heads and the point some miles north-west, where the Pliocene beds reappear from under drifts of sand. In fact, it is here that the stratigraphic equivalent of the Mangapani beds is to be expected, if, as has been suggested above, these latter constitute a horizon that is lower than that of the coralline beds at Waitotara.

THE LOWER PLIOCENE BEDS AT HAWERA AND AT KAAWA CREEK.

To the 73 species recorded by Powell (*Rec. Auck. Inst. Mus.*, vol. 1, no. 2, pp. 87–89, 1931) from Waihi Beach, Hawera, the following 40 have now to be added:—

(K indicates that the species is peculiar to the Hawera and Kaawa Creek faunules).

Nucula nitidula A. Adams.
Nucula (Linucula) aptera n.sp.
Cuna morator n.sp.
Arthritica bifurca (Webster).
Melliteryx parva (Desh.).
Virmysella n.sp.
Maurea n.sp.
Antisolarium conominolium Laws. K.
Elachorbis cingulatus (Bartrum). K.
Elachorbis hawera n.sp.
Ataxocerithium simplex Marwick.
Zegalerus tenuis (Gray).
Tanea socia (Finlay).
Cerithioderma (Miplioderma) mangawera n.subg. n.sp.
? Acirsa n.sp.
Chemnitzia ngatutura Laws. K.
Eulimella sp.
Odostomia bartrumi Laws. K.
Odostomia cf. *turneri* Laws.
Odostomia n.sp.
Waikura n.sp.
Evalea n.sp.
Pyrgulina rugata n.subsp. K.
Aeneator contractus n.sp.
Zelandiella pliocenica Powell.
Xymenella pusilla (Suter).
Inglisella hirta Laws. K.
Merica haweraensis n.sp.
Zafra impedita n.sp.
Alocospira subhebera (Marwick).
Austrotoma prolixa n.sp.
Austrodrillia koruahinensis Bartrum and Powell. K.
Bathytoma hawera n.sp.
Liracraea sata Laws. K.
Liracraea cf. *sata* Laws.
Zeacuminia planitas n.sp.
Rhizorus marwicki Bartrum and Powell. K.
Cylichnania cf. *bartrumi* Marwick.
Kaitoa cf. *recta* Marwick.
Cadulus cf. *teliger* Finlay.

It is interesting to note that 11 of the species listed above occur also at Kaawa Creek, 10 of them being found only in the Hawera and Kaawa Creek faunules. As a result of these additions the total number of species common to the two faunules now stands at 29, and there is little doubt that further search for small molluscs will show additional connection between them. The presence at Hawera of the hitherto exclusively Kaawa Creek species indicated in the above list strengthens the argument for correlation of these

two horizons. The Pyramidellid unit in the beds at Hawera affords the same evidence, for it has much in common with that at Kaawa Creek, such species as *Chemnitzia ngatutura, Odostomia bartrumi,* and *Waikura* n.sp. in particular being distinctive.

The additions in the above list bring the total number of species at Hawera to 113, and reduce the percentage of Recent species from 35·62, as determined by Powell (*Rec. Auck. Inst. Mus.,* vol. 1, no. 2, p. 89, 1931), to 23·0; compared with this the percentage of Recent species at Kaawa Creek is 21·6. Continued collecting at Hawera, however, no doubt will still further reduce this percentage.

LIMIT BETWEEN NUKUMARUAN AND WAITOTARAN ROCKS ON WANGANUI COAST.

The writer's recent collecting at Wilkie's Bluff, which is stated by Park *(loc. cit.,* p. 64) to be the finest exposure of the shell-beds of his Coralline Series, has shown that the upper limit of the Waitotaran Stage must be moved downwards in the sequence, and the base of the Nukumaruan Stage shifted correspondingly. Unfortunately, for some miles north-west of the mouth of the Waitotara River Recent sands completely obscure the coastal section just where one would expect the uppermost Waitotaran beds to make their appearance. For the same reason the basal Nukumaruan strata also cannot be studied there, though possibly the required relations may be found in the area back from the coast. The beds at Waipipi are, then, the highest members of the Waitotaran that are exposed along the Wanganui coast.

The present investigation goes to show how necessary it is not to neglect the evidence that small molluscs may have to offer, for it modifies very materially the earlier estimate of the age of the Wilkie's Bluff beds, which was based solely on the large and obvious fossils. The masses of *Crassostrea ingens* and the large pectens and the corals at first glance appear to provide a faunule so different from that at Nukumaru that stage distinction seems apparent, but closer study has shown that the difference is mainly a superficial one.

ACKNOWLEDGEMENTS.

The writer is greatly indebted to Professor J. A. Bartrum, of Auckland University College, for his ready assistance with photography, and for the suggestions he kindly made during preparation of the manuscript. To Mr. J. N. Anderson, engineer to the Patea County Council, he is also considerably indebted for help in locating certain fossiliferous outcrops along Waitotara Valley, including that at Mangapani. Mr. Anderson kindly conducted the writer by car for many miles from Waitotara Township.

SYSTEMATICS.

The types are in the author's collection.

Nucula (Linucula) wanganuica n.sp. (Fig. 10).

Shell moderately inflated, beaks about posterior third, small, directed backwards. Antero-dorsal margin short, curving downwards; anterior end truncated, the margin straight, oblique; ventral

margin regularly curved; posterior margin convex, lightly sinused at its middle; postero-dorsal margin very short, curved, descending rapidly. Upper portion of valve smooth, weak concentric sculpture developing ventrally (seen only under hand-lens). Very fine microscopic radials are also developed, and these cut the concentric ridges in a fashion reminiscent of the sculpture of *Limopsis.* Only very good specimens show the lunule ornamented by weak radial threads as described by Marwick for *Linucula.* Chondrophore triangular, oblique, broadening considerably below; teeth moderately heavy, 7 posterior to pit, about 12 in front. Margins finely crenate.

Height, 5·0 mm.; length, 5·9 mm.; inflation, 2·8 mm.

Localities: Nukumaru (type); Wilkie's Bluff.

Nucula (Linucula) aptera n.sp. (Fig. 1).

From *N. wanganuica* n.sp. this shell differs in having greater inflation of valve and fuller beak, stronger concentric sculpture, no antero-dorsal wing, and much finer teeth. *Tutamoensis, waipaoa* and *ruatakiensis* lack the regular concentric sculpture, and have the outline different. Beak at posterior fourth. Divaricating radials well seen under microscope. Hinge very light, there being 8 or 9 fine anterior teeth and about 7 posterior ones. Margins finely crenate. Radial threads present as in *wanganuica.*

Height, 3·8 mm.; length, 4·1 mm.; inflation, 1·5 mm.

Locality: Waihi Beach, Hawera.

Hochstetteria waitotara n.sp. (Figs. 2, 3).

Shell small, solid, a little oblique, prodissoconch not quite central, but not so laterally situated as that of *H. kaawa,* the species it most resembles. *Kaawa* has the beak notably broader and is a thinner shell, more circular in outline. The radials of *kaawa,* though widely spaced like those of the new shell, are heavier and not of the nature of delicate fine threads. *Waitotara* has the flat interspaces crossed by close-set concentric threads, which cause fine nodulation of radials where they cross them. The beak rises prominently above hinge, which is fairly broad. Ligamental pit triangular; on each side of it the hinge bears about 20 vertical taxodont teeth, extending for equal distances on each side of the pit. Internally the whole of the ventral margin and the ventral parts of anterior and posterior margins are crenulated.

Height, 1·7 mm.; length, 1·7 mm.; inflation (one valve), 0·6 mm.

Locality: Wilkie's Bluff.

Gaimardia asinuata n.sp. (Fig. 12).

Of Neozelanic species this fossil most resembles *G. coccinea* Hedley, a Macquarie Island species. It differs from other local species in the almost total absence of sinuation on ventral margin, the beaked effect at anterior being much less obvious than in *coccinea, forsteriana* and *aucklandica.* It is notably smaller than *coccinea,* and equally notably larger than the last two species. Except for the unsinuated ventral margin and for the rather more

erect posterior one, the outline is that of *coccinea*. The beak, however, is more turned inwards. In characters of hinge these two species resemble one another very closely. The fossil has tooth of left valve rather better developed. The right valve has a lamellar tooth developed below and just in front of beak; above this there is a groove that engages the tooth of the left valve. *Coccinea* has these teeth barely developed (right valve). Sculpture consists of concentric growth-ridges and striae and weak radial lines and very low folds, mostly towards posterior end, much as in *coccinea*. There is a broad fold running from umbo to postero-ventral margin.

Height, 5·0 mm.; length, 6·1 mm.; inflation (one valve), 1·6 mm.

Locality: Nukumaru.

Cuna morator n.sp. (Fig. 14).

Shell minute, higher than long, posterior and anterior margins descending rapidly, straight; ventral margin convex, drawn down anteriorly. Hinge typical. The only other New Zealand species with which this may be compared is *C. crassicardo*, also a Waitotaran fossil (Kaawa Creek). Both are alike in possessing concentric sculpture; *morator* is at once distinct, however, for its concentric ornamentation takes the form of excessively fine, hair-like threads, under the microscope seen to be sharply elevated and separated one from the other by grooves whose width is about twice that of the ridges. The sculpture of *crassicardo* is very much coarser, and consists of broad, rounded corrugations.

Height, 1·3 mm.; length, 1·0 mm.

Locality: Waihi Beach, Hawera.

Cuna nukumaruensis n.sp. (Fig. 13).

This species is one of a series comprising *otagoensis* Powell, *gibbosa* Powell, *kaawa* Laws, all very like *Hamacuna hamata* (Hedley), but not having the beak so prominently thrust forward and then bent over downwards. Of the three Neozelanic species this Nukumaru fossil resembles *C. kaawa* most closely in shape; in fact the outlines are almost identical in the two forms. The Kaawa species, however, has the lunule longer and more sunken and the escutcheon better differentiated and bordered by a distinct ridge; it also has very low, broad radials; the new species is unsculptured. Both species have crenulated ventral margins, the crenulations of Nukumaru species being the finer. In the hinge there are differences. *Kaawa* has the edge of hinge-plate of left valve regularly arched, that of *nukumaruensis* being very strongly cut into between the two strong teeth. The right valve of *kaawa* has the anterior lateral and its bordering groove longer and narrower. *Otagoensis*, like *kaawa*, has low radial ribs and crenulated margins, but is distinct from both the above species in that it is more attenuate dorsally and has not the beaks so twisted. Amongst other differences the margins of *gibbosa* are smooth.

Height, 2·2 mm.; length, 2·05 mm.; inflation (one valve), 0·6 mm.

Localities: Nukumaru (type); Wilkie's Bluff.

Pleuromeris paucicostata n.sp. (Figs. 7, 8).

Closely allied to *marshalli* Marwick, but is a larger and more heavily built species with much coarser ribbing and dorsal side drawn up a good deal more. The ribs are broad and heavy, and are separated by wide, shallow, almost flat-floored interstices, which are broader in relation to width of axials than are those of *marshalli.* The ribs are only 8 or 9 in number as compared with 11 or 12 in *marshalli,* from which species the large, heavy, shell and different ribbing provides ready separation.

Height, 8·9 mm.; length, 7·5 mm.; inflation, 3·0 mm.

Localities: Nukumaru (Nukumaruan); Devil's Elbow, Napier-Wairoa Road; Kawau Island, in 20 fathoms (Recent).

Type from Nukumaru. The type-material consists of odd right and left valves.

Scissurona fossilis n.sp. (Fig. 20).

Shell auriform, imperforate, spire very slightly elevated. Sculpture of thin, spaced spiral threads and curved axials, these two elements of equal strength, giving a fenestrated effect. In fact, the sculpture very closely indeed resembles that of *Scissurella geoffreyi,* a fossil from Kaawa Creek. The present shell, however, has the broadly spreading aperture, concave columella and almost completely covered umbilicus of *S. rosea* (Hedley), the genotype of *Scissurona.* Slit deep, situated above periphery, not crossed by lamellae.

Diameters: Greatest, 1·3 mm.; least, 1·0 mm.

Localities: Nukumaru (type); Wilkie's Bluff.

Schismope sp.

Two specimens, the preservation not good enough for accurate discrimination.

Locality: Wilkie's Bluff.

Elachorbis hawera n.sp. (Figs. 22, 29).

Shell large, last whorl enlarging rapidly; upper surface convex. Spire low, its whorls lightly rounded; sutures distinct. Protoconch closely coiled, its nucleus minute. Surface smooth to unaided eye, but hand-lens shows numerous fine spiral threads. Periphery sharply rounded low down, almost angled. Base practically smooth. Umbilicus small, its width about $\frac{1}{7}$ to $\frac{1}{8}$ that of least diameter of shell.

Diameters: Greatest, 6·5 mm.; least, 5·1 mm.

Locality: Waihi Beach, Hawera.

Distinct in its lack of prominent sculpture; large size and sharply angulated, narrow periphery; laterally spreading aperture, in which respect it resembles *edomita* Marwick.

Elachorbis unicarina n.sp. (Fig. 5).

Spire very low, whorls convex, suture channelled broadly, umbilicus wide and perspective. The body-whorl bears about eight distinct regular spiral cords, the first from suture being on rim

of channel, the last forming a keel well below periphery and almost on outer edge of base. These cords become stronger and more distant from suture downwards. Base smooth.

Diameters: Greatest, 2·7 mm.; least, 2·0 mm.

Localities: Wilkie's Bluff (type); Mangapani; Devil's Elbow, Napier-Wairoa Road.

Not unlike the Recent *sub-tatei* (Suter), but the smooth base distinguishes it. *Albolapis* Laws has spirals on the base. *Politus* (Suter) has the spirals much finer. The specimen of *unicarina* from Hawke's Bay has the channel around suture not so strongly excavated.

Brookula (Aequispirella) cf. **finlayi** Powell.

One shell, probably a new species, close to *finlayi*, but with few axials and the umbilicus rather more open. Specimen not good enough for description.

Locality: Wilkie's Bluff.

Crosseola waitotara n.sp. (Fig. 18).

This species has very much the form of *C. errata* Finlay, from which it is readily distinguished, however, by more numerous spirals on the body (9 or 10 as against 6); there is canaliculation at base of aperture, very distinct in young shells, but shallower in adults. *Cuvieriana* (Mestayer) is apparently taller spired and has fewer spirals (5 on body). *Intertexta* Powell is much smaller, has fewer spirals, 5 of which denticulate the outer lip (only 4 do this in the new species), their distribution around the lip different, the lowest one of *waitotara* being well down on basal lip. *C. munditia* Laws is similar, but has only 5 spirals on the body, and 2 (not 3 as in *waitotara*) on spire-whorls. The outer lip is reinforced externally by crowding of growth-lines. Umbilical rib not crenulated, but crossed by thin axial threads.

Height, 3·05 mm.; width, 2·8 mm.

Locality: Wilkie's Bluff.

Notoacmea (Parvacmea) nukumaruensis Oliver.

Several dozen very well preserved specimens have been collected. These show the surface to be sculptured with very numerous, dense radial threads, a feature not commented on at the time of description, owing no doubt to lack of the best material.

Locality: Nukumaru.

Estea jacosa n.sp. (Fig. 32).

Related to *subtilicosta* Marwick, but notably smaller and with relatively larger aperture, which is circular. Spire lightly convex in outline, sutures moderately distinct; whorls clasping, faintly convex and rather bulging anteriorly. Height of body greater than half that of shell. Body-whorl narrow; aperture with its rim trumpet-like, heavily thickened on parietal wall; aperture as wide as, or perhaps rather wider than, the body.

Height, 1·8 mm.; width, 0·8 mm.

Locality: Wilkie's Bluff.

Estea rekominor n.sp. (Fig. 15).

This species has relationship with both *rekohuana* Powell and *minor* (Suter). From *rekohuana* it differs in having the whorls more clasping and sutures tangential, the height of body not so great relative to height of shell, and the aperture different, its posterior border being more nearly horizontal. *Minor* is smaller and has the whorls bulging, those of *rekohuana* and of *rekominor* being flat.

Height, 2·1 mm.; width, 1.0 mm.

Locality: Nukumaru.

Estea missile n.sp. (Fig. 11).

Shell small, narrow, outline pupoid, whorls flat to very lightly convex, often bulging a little below, and thus slightly overhanging suture. Periphery sub-angled, the angulation bearing a fine spiral groove. Suture below periphery, the spiral thus in evidence above suture. Not unlike *morioria* Powell in shape, but the presence of peripheral angulation and of supra-sutural spiral distinguishes it. *Porrectoides* is also a tapering species, but has not the angulation and coarse spiral. *E. ngatutura* is consistently much smaller.

Height, 2·1 mm.; width, 0 98 mm.

Localities: Mangapani (type); Nukumaru.

Rissopsis nukumaruensis n.sp. (Fig. 6).

This is an exquisitely fashioned little species, taller than either *fricta* or *castlecliffensis,* and having the heterostrophe protoconch similar to that described by Powell for *expansa.* The embryo of *fricta* has the nucleus minute, that of both *nukumaruensis* and *castlecliffensis* being much larger. Whorls well rounded, sutures strongly cut in, the summit of whorls being shouldered close in to suture. All adult whorls crossed by close, fine (hair-like under hand-lens) straight, slightly oblique axials, which extend well down on to base. Numerous fine spiral threads, rather finer than the axials, are universally developed. Aperture typical, elongate-oval, lips thin, peristome discontinuous. Height of body-whorl about half that of shell.

Height, 2·5 mm.; width, 0·9 mm.

Locality: Nukumaru.

Manawatawhia aedicula n.sp. (Fig. 30).

Shell minute, attenuate, whorls convex, sutures distinct. Protoconch with five thin raised spiral threadlets, spaced widely on posterior part of whorl, but closer together in front. Axial sculpture almost obsolete, indicated by exceedingly low corrugations, and present on all post-nuclear whorls. Body-whorl long, its height not quite half that of shell. Aperture similar to that of *analoga* Powell; peristome continuous; parietal callus thick.

Height, 1·0 mm.; width, 0·25 mm.

Locality: Wilkie's Bluff.

Dardanula laevicordata n.sp. (Fig. 33).

Shell minute, spire elevated (about twice height of aperture), whorls lightly convex to flat, sutures moderately defined, impressed, situated slightly below periphery. Aperture roundly ovate; outer

lip thin, slightly effuse; columella arcuate, set vertically, a slight umbilical chink present near its insertion. Outer lip antecurrent to suture, which descends to meet aperture. Good specimens show low, faint spirals over surface of last two whorls.

Height, 1·25 mm.; width, 0·75 mm.

Locality: Nukumaru.

Ataxocerithium perplexum Marshall and Murdoch.

Five specimens from Mangapani are undoubtedly Marshall and Murdoch's *Ataxocerithium perplexum*. Like Nukumaru shells they are considerably worn, but one is sufficiently preserved to show the sculpture and carination of *Zeacumantus lutulentus* (Kiener), to which Marshall and Murdoch's name must fall in synonymy.

Specula cf. **retifera** (Suter).

Shells from Nukumaru and Mangapani have characters close to those of this species. The protoconch, however, seems less bulging, but this may be due to wear, and the nodules are finer.

Genus NOTOSINISTER Finlay.

Genotype (o.d.): *Triphora fascelina* Suter.

Subgenus CAUTOTRIPHORA n.subg.

Genotype: *Cautotriphora simulans* n.sp.

This subgenus is provided for a Nukumaru fossil possessing in its adult whorls the characters of *Notosinister*, but differing widely in the nature of its embryonic whorls. Superficially the protoconch resembles that of *Isotriphora* Cotton and Godfrey, but microscopic examination shows notable differences. *Isotriphora* has the summit "blunt, with nodular sculpture retained to the apex." In the New Zealand fossil two spiral cords immediately issue from the apex, separated by a wide, shallow groove. Nodulation begins before the first half turn is completed. On the lower cord the nodules rapidly increase in prominence, but the nodulation is not as heavy as that shown in Cotton and Godfrey's figure of *tasmanica*, the genotype of *Isotriphora* (*S.A. Naturalist*, vol. 12, no. 4, p. 52, pl. 1, figs. 3 and 4, 1931). The nodules are connected axially by strong ribs, and this seems not to be a feature of the Australian genus.

Cautotriphora simulans n.sp. (Fig. 24).

The protoconch is described in the generic diagnosis above. The embryonic volutions (about 2½ in number) increase slowly; the early post-embryonic whorls increase rapidly at first and then gradually; thus the protoconch as a whole projects in mucronate fashion. The embryo closes at an ill-defined varix, issuing from which there are three spirals, a third now appearing between the original embryonic ones. All adult whorls with three spiral keels, evenly and regularly nodulated, the nodules connected axially by ridges, weaker than the spirals, giving a fenestration of squares. Sutures margined above by a thin thread, which issues from suture on body-whorl as a distinct cord marking the sharply angled periphery. Base with two spiral threads.

Height, 7·0 mm.; width, 2·0 mm.

Locality: Nukumaru.

The resemblance to *Isotriphora* is superficial. It is more likely that the New Zealand shell has arisen from a local group, such as *Notosinister* or *Cautor,* possibly the latter.

Zeacolpus propagodus n.sp. (Fig. 25).

Shell not large, whorls lightly convex, sutures distinct. Protoconch typical of *Zeacolpus,* sculpture beginning as a keel towards close of embryonic coiling. Finlay (*Trans. N.Z. Inst.,* vol. 61, pp. 230–1, 1930) in comparing the species *vittatus, pagodus, fulminatus, ahiparanus,* and *mixtus,* has conveniently employed letters to describe the four main spirals that develop on early post-embryonic whorls, lettering them A, B, C, D from the top downwards. For ease of comparison this system is employed in the present description. As in *pagodus,* C begins as a strong keel, and always remains the strongest. D develops next as a thin but distinct thread; soon after A and B appear as very delicate threads indeed. B rapidly increases in strength, while D and A remain thread-like. On later whorls C is always the most prominent, while B is next in prominence, A and D being indistinguishable from secondary threads. Whorls thus have a bicarinate effect, the keels being of equal strength and dividing the whorl into thirds. In some specimens B is slightly weaker than C. The base has 5 or 6 spaced spiral threads. The early post-nuclear whorls are strongly unicarinate like those of *pagodus.*

Height (estimated), 15·0 mm.; width, 5·0 mm. Larger specimens occur.

Locality: Wilkie's Bluff.

Stiracolpus haweraensis Powell.

Numerous topotypes have been obtained. The writer has this species also from Mangapani, Wilkie's Bluff, and from an outcrop near Devil's Elbow (Napier-Taupo Road). The keels on the shells from these localities are slightly heavier and a little more distant one from the other, but otherwise they agree well with topotypes. Hawera specimens show some variation in regard to the strength and number of secondary spirals; some shells have the secondaries fine, even dense; others have only one or two rather stronger secondaries between the pairs of keels.

Tanea socia (Finlay).

Three specimens were collected at Hawera. The species occurs also at Kaawa Creek.

Polinices sp.

One very striking specimen with the umbilical perforation deep and entering right to the top of the shell, seeming to be more penetrating than that of *sagenus.* The parietal callus is worn and outer lip badly broken back.

Locality: Mangapani.

Cerithioderma cavatocarinata n.sp. (Fig. 19).

These shells carry the same number of spirals as *octocarinata* (Powell) and also like that species lack the prominent shoulder of *inornata.* Unlike the former, however, the posterior of spire-whorls

has two distinct, though fine, spirals developed, and not a broad swelling as in *octocarinata.* Further, *octocarinata* has the aperture almost equal in height to that of the spire, whereas the new species has the height of the whole body about half that of the shell. The shell of *cavatocarinata* is thus more attenuate.

Height, 6·0 mm.; width, 3·7 mm.

Localities: Off Otago Heads, in 72 fathoms (type); Nukumaru; Mangapani. The shells from Nukumaru, though stumpier than the Recent ones from Otago Heads, lack the shoulder of *inornata* and have fewer spirals.

Genus CERITHIODERMA Conrad.

Genotype: *C. prima* Conrad.

Subgenus: MIPLIODERMA n.subg.

Genotype: *Miplioderma mangawera* n.sp.

The protoconch is large, its summit flattened and blunt; smooth. The nucleus on the flattened summit is minute, closely coiled in planorboid fashion. After the first 1½ turns the coiling descends in helicoid volutions, the whorls enlarging rapidly, becoming strongly convex, and persisting for just over two turns to close of embryo. The large protoconch appears out of proportion to the size of the early adult whorls. The anterior canal is better defined than that of *inornata,* being not so open, and longer; the beak is twisted somewhat to left; umbilicus entirely closed; there is no swollen rib comparable with that on *inornata* and related forms running from beak and bordering left side of umbilicus.

Cerithioderma (Miplioderma) mangawera n.sp. (Fig. 17).

The form of this Pliocene species is entirely that of *Trichosirius finlayi* Laws, a fossil occurring in Hutchinsonian and Awamoan beds in the South Island. The new species, however, is smaller, more lightly built, and has the axials much less oblique with respect to posterior suture. The posterior one of the three strongest spirals is higher up on whorl in *mangawera,* and above it there is one fairly strong spiral. *Finlayi* has two, and sometimes three, spirals between suture and the posterior of the three heavy cords; and these spirals are always much finer than the cords, appearing as spaced, thin but distinct thread.

Height, 8·5 mm.; width, 4·4 mm.

Localities: Mangapani (type); Hawera.

Funiscala nympha (Hutton).

So far as the writer is aware this species has been known up till now only from the Pliocene beds at Petane. It is extremely close to *F. maxwelli* Finlay, occurring in deep water off Otago Heads.

Locality: Mangapani.

Gumina minor n.sp. (Fig. 16).

Shell very small, spire staged, body-whorl equal to spire in height, of about three post-nuclear whorls, the last one disproportionately long and narrow; outlines straight. Whorls convex, a little flattened around suture, which is distinct. Protoconch

heterostrophic, paucispiral, planorboid, well rounded and considerably tilted. Spiral sculpture of weak, irregular striae here and there, but rather better developed than in the genotype *(G. dolichostoma)*; growth-stages well seen. Body-whorl long, widely convex in one broad sweep from suture to base; aperture elongately oval, narrowly angled behind, rather broadly rounded in front; columella set vertically, strongly arcuate, its fold indicated externally by a low swelling near junction with parietal wall, and becoming more strongly differentiated within aperture; inner lip with a narrow, well developed pad of callus; outer lip thin, lightly convex.

Height, 2·5 mm.; width, 1·1 mm.

Locality: Mangapani (type). Also occurs Recent.

Balcis cf. **christyi** (Marwick).

The shells from Wanganui localities scarcely show the slight anterior bulge typical of *christyi.*

Localities: Nukumaru; Wilkie's Bluff.

Aeneator contractus n.sp. (Figs. 27, 28).

Shell of moderate size, attenuate, body not unduly inflated. Whorls convex; sutures distinct, margined by a low, moderately broad spiral. Whorls rising steeply above shoulder. Axials developed on all whorls, the interspaces rather narrower than the ribs; 12 axials on last whorl, no obsolescence of axials evident. The whorls are higher in relation to width than are those of *marshalli* and *imperator,* more like those of *attenuatus.* Axials are not so sharply defined as those of *imperator* and the spirals (about 28 on body-whorl, each pair with an interstitial threadlet) are finer. Anterior canal long. Protoconch typical of the genus.

Height (estimated), 45·0 mm.; width, 15·0 mm.

Locality: Hawera.

Zeadmete teres n.sp. (Fig. 21).

A very delightfully preserved shell, more slender than any of its associates in *Zeadmete,* quite devoid of axial sculpture, and having fine, close, evenly spaced and regular spiral cords over whole adult surface; 12 spirals on penultimate whorl. Whorls strongly shouldered, the suture almost channelled. The two folds on columella are equal in strength. Protoconch normal.

Height, 7·7 mm.; width, 4·1 mm.

Locality: Nukumaru.

Merica haweraensis n.sp. (Fig. 26).

Closely allied to *M. maoria* (Marshall and Murdoch), an Awamoan fossil from Target Gully. It is, however, considerably larger, has the sutures very deeply channelled and the fenestration of sculpture closer. The spire-whorls have three spiral cords (two in *maoria*); the body-whorl four heavy ones (three in *maoria*), and four or five fine spaced threads anterior to them. Axials on body 14 in number (12 in *maoria*). Nodules at intersections of spirals and axials present on all whorls. Columella with three strong, evenly

spaced plaits. Inner lip fairly thickly callused. The protoconch is polygyrate, closely coiled, and has the nucleus tiny and central. Outer lip broken.

Height (estimated), 20·0 mm.; width (estimated), 10·0 mm.

Locality: Hawera.

Zafra impedita n.sp. (Fig. 4).

Related to *Z. opihiensis* Laws, a fossil from Awamoan beds in South Canterbury, but separable on account of the more numerous and finer axials (18 or 19 on penultimate whorl; 11 or 12 on that of *opihiensis*), more cut in suture, and less swollen sub-sutural spiral. In apical characters the two forms are identical, the protoconch being conical, polygyrate and sharply pointed, its nucleus minute and base broad. Both also have the two small denticles on mid-portion of columella, separated by a light groove. Were it not for the protoconch these species would fall into *Macrozafra,* for they agree in build, sculpture and denticulation of columella with *M. subabnormis* (Suter), the genotype of *Macrozafra.*

Height, 6·1 mm.; width, 3·0 mm.

Localities: Mangapani (type), common; Wilkie's Bluff; Petane; Hawera.

Just as these shells placed in *Zafra* differ from *Macrozafra* in nuclear characters, so *Zemitrella inconspicua* (Marshall), a fossil from the Pakaurangi Point beds, differs from other Neozelanic *Zemitrella,* as has been remarked by the writer (*Trans. Roy. Soc. N.Z.,* vol. 68, p. 496, 1939). If group-names are not already available for those forms with polygyrate apices, it seems that generic distinction should be accorded them.

Austrotoma prolixa n.sp. (Fig. 9).

Shell with spire very elongate and slowly tapering, whorls as high as broad, shouldered above posterior third, the shoulder concave and rising steeply to suture, which is clasping. Below shoulder whorl descends vertically and is practically straight. Shoulder with a swollen border around suture, and a thin spiral thread at about its anterior third, elsewhere with fine spiral striae and curved growth-lines. Antepenultimate whorl with six strong, sharply raised and evenly spaced spiral cords, nodulated weakly where crossed by axials, the nodulation strongest on posterior cords, hardly visible on anterior one or two. Body-whorl with 14 strong, spaced spiral cords, the upper few faintly nodulated; interstitial spirals absent. Axials very weakly developed, indefinite, indicated chiefly by nodulation on spirals; some better developed than others, persisting weakly across spiral grooves; all axials weakening and many dying out entirely towards anterior of whorls. Sinus moderate, as indicated by growth-lines on shoulder. Anterior notch broken away, but growth-lines on fasciole show it was moderately deep. Aperture narrowly ovate, angled behind. Sutures very oblique to the horizontal.

Height (estimated), 70·0 mm.; width, 22·0 mm.

Locality: Hawera.

Separable at a glance from all other Neozelanic *Austrotoma* on account of its tenuity of whorl and spire, and large size.

Bathytoma hawera n.sp. (Fig. 23).

Shell tall and slender, outline of spire straight, protoconch missing. Whorls with a broad, prominent rounded median keel carrying three or four spiral cinguli; above keel three fine subequidistant spirals; below keel two spirals, the lower the heavier. Suture margined below by a swollen band consisting of two strong close nodular spirals, the nodules connected axially across interspace. Body-whorl with 15 raised and spaced spiral cords, the last half-dozen or so becoming finer, though still well elevated; most of the interspaces with an interstitial threadlet. Sinus normal.

Height, 28·0 mm.; width, 10·0 mm.

Locality: Hawera.

The unusually slender habit distinguishes this species at a glance.

Phenatoma n. sp.

Pliocene shells from several localities differ in a number of ways from the Recent *P. zelandica* (Smith). They are more attenuate (body much less swollen) than *zelandica,* have whorls not so strongly shouldered, and lack the broad smooth zone on whorls.

Localities: Mangapani; Devil's Elbow, Hawke's Bay.

Liracraea cf. **sata** Laws.

Three shells differing from *sata* in that they are notably less slender and have the protoconch larger and broader across the base.

Locality: Hawera.

L. sata, a Kaawa Creek species, has been collected also at Waihi Beach, Hawera.

Zeacuminia planitas n.sp. (Fig. 31).

Shell small, elevated, outlines convex above, straight below. Whorls broadly sulcate medially; sutures narrow at periphery. Whorls axially ribbed, the ribs vertical, straight, nodulated at both extremities, the nodules at anterior ends rather sharper and stronger than those behind. Penultimate whorl with 12 to 14 ribs, spaced at intervals greater than their own width. Body-whorl swollen and pouting around periphery, contracting rapidly over short base to strongly twisted neck and well developed fasciole.

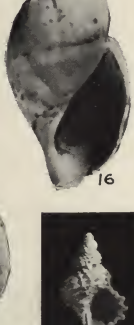
Height, 10·0 mm.; width, 3·1 mm.

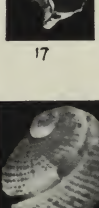
Locality: Hawera.

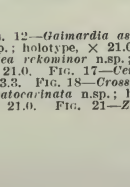
Somewhat like *Z. biplex* (Hutton), and *Z. turpicula* Marwick.

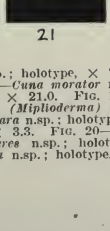
FIG. 1—*Nucula (Linucula) aptera* n.sp.; holotype, × 10.4. FIG. 2—*Hochstetteria waitotara* n.sp.; holotype, × 21.0. FIG. 3—*Hochstetteria waitotara* n.sp.; holotype, × 21.0 FIG. 4—*Zafra impedita* n.sp.; holotype, × 9.6. FIG. 5—*Elachorbis unicarina* n.sp.; holotype, × 21.0. FIG. 6—*Rissopsis nukumaruensis* n.sp.; holotype, × 21.0. FIG. 7—*Pleuromeris paucicostata* n.sp.; holotype, × 3.1. FIG. 8—*Pleuromeris paucicostata* n.sp.; holotype, × 3.1. FIG. 9—*Austrotoma prolixa* n.sp.; holotype, × 1.0. FIG. 10—*Nucula (Linucula) wanganuica* n.sp.; holotype, × 10.0. FIG. 11—*Estea missile* n.sp.; holotype, × 21.0.

To face page 56









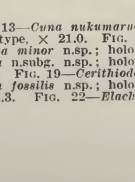
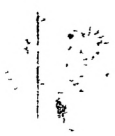


Fig. 12—*Gaimardia asinuata* n.sp.; holotype, × 7.8. Fig. 13—*Cuna nukumaruensis* n.sp.; holotype, × 21.0. Fig. 14—*Cuna morator* n.sp.; holotype, × 21.0. Fig. 15—*Estea rekominor* n.sp.; holotype, × 21.0. Fig. 16—*Gumina minor* n.sp.; holotype, × 21.0. Fig. 17—*Cerithioderma (Miplioderma) mangavera* n.subg. n.sp.; holotype, × 3.3. Fig. 18—*Crosseola waitotara* n.sp.; holotype, × 16.3. Fig. 19—*Cerithioderma cavatocavinata* n.sp.; holotype, × 3.3. Fig. 20—*Scissurona fossilis* n.sp.; holotype, × 21.0. Fig. 21—*Zeadmete teres* n.sp.; holotype, × 3.3. Fig. 22—*Blacharbis hawera* n.sp.; holotype, × 3.3.



23

24

25

26

27

28

29

30

31

32

33.

Fig. 23—*Bathytoma hawera* n.sp.; holotype, × 1.7. Fig. 24—*Notosinister (Cautotriphora) simulans* n.subg. n.sp.; holotype, × 7.5. Fig. 25—*Zeacolpus propagodus* n.sp.; holotype, × 3.3. Fig. 26—*Merica haweraensis* n.sp; holotype, × 3.3. Fig. 27—*Aeneator contractus* n.sp.; holotype, × 3.3. Fig. 28—*Aeneator contractus* n.sp.; paratype, × 3.3. Fig. 29—*Elachorbis hawera* n.sp.; holotype, × 3.3. Fig. 30—*Manawatawhia aedicula* n.sp; holotype, × 21.0. Fig. 31—*Zeacuminia planitas* n.sp.; holotype, × 3.3. Fig. 32—*Estea jocosa* n.sp.; holotype, × 21.0. Fig. 33—*Dardanula laevicordata* n.sp.; holotype, × 21.0.

To follow plate 6